

ART. XII.—*Probable Miocene Age of a Conglomerate at Shelford.*

(With Plate VII.).

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For some years boulders of gritty ironstone containing casts of fossils have been reported by various observers as occurring on a hill adjoining the Shelford Cemetery, but the material appeared so unpromising that geologists have hitherto abstained from undertaking a detailed examination of it. The position of the boulders *on* the basalt precludes their being classed as a portion of the eocene, which underlies this rock not only in sections close at hand but also in those of neighbouring areas, and the opinion has indeed been hazarded that they might be pliocene, mainly perhaps, because that age had been previously assigned to the lava flows around.

We first saw blocks of the conglomerate placed amongst basaltic boulders along a portion of the fence bordering an unformed road up the western slope of the Leigh River Gorge. It was too late when we arrived in Shelford to seek for them *in situ* that day, and we were, in fact, told that our search would be fruitless, as the oldest inhabitant could give no information as to where the stones came from. This mystery, however, was, as we anticipated, easily cleared up the next morning, since they were found in abundance just below the surface in the adjoining paddock, from which, of course, the loose stones had been picked up, and then piled against the fence. This paddock lies south of the road and adjoins the cemetery, in which also embedded blocks of the conglomerate are common. The same material also crops out in a shallow gully, just over the fence on the opposite or southern side of the paddock, but ceases on the rising ground beyond. To the north of the road, we could find no trace of the fossiliferous strata, nor indeed in any other part of the gorge, though we searched at about the same level in several places. We should certainly expect similar boulders to occur elsewhere on the river bank, and possibly a more thorough search may

yet reveal them. Going up the road by the side of the fence, the conglomerate commences near the cemetery gate and disappears about 140 yards from the top of the hill. Further details concerning the elevation and horizontal measurements of the outcrop will be more conveniently given later on.

The matrix of the boulders consists of ironstone with numerous small, rounded, quartz pebbles irregularly scattered throughout the mass. There is no creek or cutting where they occur, and we noticed them merely as slight protrusions here and there in the surface soil, much in the same way as blocks of lava appear on the plains and hill slopes of ordinary basaltic country. They are crowded with fossils, but all as casts only, the lime of the shell being entirely replaced by iron oxide. When the cast is an internal one, the fossil is not, as a rule, easily identified, but with an external cast, or rather mould, where, as is often the case, the ornament of the formerly enclosed shell is clearly delineated, there is less difficulty; and besides, the opportunity is afforded of reproducing its outline and exterior markings in some plastic material. Our own attempts at this were only moderately successful, and we were very glad to avail ourselves of the generous offer made by Mr. G. Sweet, F.G.S., to prepare models from the fossil casts obtained. Our heartiest thanks are due to this gentleman, as he has enabled us to determine with certainty many of the forms represented.

One of the commonest casts is that of *Pecten anti-australis*, the exterior ornament of which is often beautifully preserved. Amongst other easily identifiable casts may be mentioned, *Zenatiopsis angustata*, of large size, *Pellicaria coronata*, *Chione propinqua* (mioc. var.), *Myodora corrugata*, *Leda woodsii*. Models of all of these have been prepared, as well as of the majority of the other species catalogued.

In the following table of fossils from the conglomerate, the asterisk before the name signifies that the species is represented by many examples. The dagger indicates that fossils from this bed were also so identified by Professor Tate from casts sent to him some years ago by Mr. Sweet. Having been allowed to examine the same collection, we are able with the additional material on hand and by the aid of the models prepared to omit the query then placed against some of the names.

TABLE OF FOSSILS WITH THEIR DISTRIBUTION.

Name of Fossil.	Miocene.			Other Occurrences and Remarks.
	Muddy Creek.	Gippsland.	South Australia.	
<i>Cancellaria warrnonensis</i> , <i>Tate</i> -	-	-	-	-
*† <i>Pellicaria coronata</i> , <i>Tate</i> -	-	-	-	-
<i>Diastoma</i> ? sp. -	-	-	-	-
<i>Calyptraea corrugata</i> , <i>Tate</i> -	-	-	-	-
<i>Astele</i> sp. († <i>Trochus</i> sp.) -	-	-	-	-
<i>Emarginula</i> sp. -	-	-	-	-
<i>Cylichna</i> sp. -	-	-	-	-
* <i>Ostrea arenicola</i> ? <i>Tate</i> († O. sp.) -	-	-	-	-
*† <i>Pecten anti-australis</i> , <i>Tate</i> -	-	-	-	-
<i>Mytilus</i> sp. -	-	-	-	-
† <i>Modiola</i> sp. -	-	-	-	-
<i>Pectunculus camozoicus</i> , <i>T. Woods</i> -	-	-	-	-
* <i>Nucula tenuisoni</i> , <i>Pritchard</i> -	-	-	-	-
* <i>Leda woodsii</i> , <i>Tate</i> -	-	-	-	-
<i>Leda vagans</i> , <i>Tate</i> -	-	-	-	-
<i>Cardita solida</i> ? <i>Tate</i> -	-	-	-	-
*† <i>Chione propinqua</i> , <i>T. Woods</i> -	-	-	-	-

Well sinking, Murray Desert.

aff. *A. granosa*, *Tate*, m.s.aff. *B. candida*, *Reeve*.

New sp. ?

Eoc. various localities.

do.

do.

do.

Cheltenham.

Muddy Creek var.; abundant there in upper beds, scarce in lower.

TABLE OF FOSSILS—(Continued).

Name of Fossil.	Miocene.			Other Occurrences and Remarks.
	Muddy Creek.	Gippsland.	South Australia.	
<i>Chione subroborata</i> , Tate	-			
* <i>Dosinia johnstoni</i> , Tate	-	X		Eoc. Table Cape, etc.
<i>Solecurtus dennanti</i> , Tate	-	X		Eoc. various localities.
<i>Mastra</i> sp.	-			New sp. ?.
<i>Mastra</i> ? sp.	-			
*† <i>Zenatiopsis angustata</i> , Tate	-	X	X	Cheltenham. Eoc. Table Cape, R. Murray. A characteristic shell of the upper beds Muddy Creek; not present in the lower.
* <i>Corbula ephamilla</i> , Tate	-	X	X	Eoc. various localities.
<i>Lucina affinis</i> ? Tate	-		X	
<i>Tellina</i> ? sp.	-	?		
* <i>Myodora corrugata</i> , Tate	-	X	X	
† <i>Waldheimia</i> ? sp.	-			
† <i>Cellepora</i> sp.	-			
† <i>Retepora</i> sp.	-			

That the above list of fossils is a short one, as compared with those usually supplied for the tertiary deposits of the province must be attributed to the difficult nature of the material in which they are embedded rather than to the scarcity of the forms present. Many of these, from their small size, or indefiniteness of the preserved outlines are quite unrecognisable, while for others models have to be prepared. Even with the aid of these, the species, and occasionally the genus also, may still remain doubtful, especially in the case of bivalves, where the hinge characters can rarely be made out.

In discussing the horizon of the strata we propose to take account only of those fossils the distribution of which is definitely given in the table. Eighteen species are thus available, of which eight are confined to the miocene division of the tertiaries at Muddy Creek, Jemmy's Point, Aldinga Bay, or the Murray River; while many of the remainder though present also in the eocene, are in reality specially characteristic of the miocene. With only eighteen species as a basis for calculation, the percentage of living forms represented would of course be an unreliable test of geological age. As a fact, no undoubted recent species appears in the list, though it may be mentioned, that one of them, viz., *Nucula tenisoni*, formerly known as *N. tumida*, T. Woods, is regarded by Mr. Pritchard as both recent and fossil.* Under these circumstances reliance is placed upon the correlation of the fauna with that in other deposits, which, if correctly given in the above columns, indicates a miocene horizon for the Shelford Conglomerate. On stratigraphical as well as on palæontological grounds, the deposit must be separated from the neighbouring eocene, while to be even late pliocene, it should show a large proportion of recent shells. Its relation to the accompanying igneous rock has next to be considered, and with reference to this our hesitation in at once classing the strata as miocene, when first met with, was chiefly due, since previous conclusions concerning the age of the basalt are thereby called in question.

The position of the outcrop, as well as our theory of the sequence of the rocks is illustrated in the appended sketch,

* Roy. Soc. Vic., vol. viii., p. 128.

which is approximately to scale. The elevations are from aneroid observations of our own, and the distances of the stations on the hillside have been measured for us by Mr. Swan.

At the particular portion of the river bank where the conglomerate appears, the eocene beds are not visible, but we consider ourselves justified, from evidence obtained at other portions of the gorge, in assuming their existence here, and at no great depth beneath the basalt; at the base of the section they may indeed be somewhat more deeply seated than the drawing indicates, while the outline of their surface farther in the hill is of course uncertain. North of Shelford, outcrops of the strata also occur, but generally reaching a higher level on the banks, and an uneven surface is thus indicated, which points to erosion before the outflow of the lava took place. In the section figured, the basalt appears first at a height of fifty feet above the water's edge, and our conclusion that it is there *in situ* is confirmed by the fact that the eocene strata of the Red Bluff, a mile and a half down the stream, are covered by lava at about the same elevation. Going still farther up the hill, a moderately deep quarry in solid basalt is 110 feet above the same datum line. Beyond this quarry and at a height of 145 feet above the river level, the first block of the conglomerate *in situ* was observed. A few scattered pieces were found on the surface a little lower down, but they have probably come from above. The fossiliferous boulders can be traced up the hill from this point for a distance of about 150 yards, and for thirty-five feet in vertical elevation, or to a height above datum line of 180 feet, when they cease, and the only stones cropping out higher up belong to the prevailing lava flow. By a farther rise of forty feet in a distance of 137 yards, the summit of the western bank of the river gorge is reached, its total height being thus 220 feet. The distance from the water's edge to the level country bounding the gorge is 766 yards, so that the slope, like that on basaltic banks generally, is a gentle one. On the east of the river there is an extensive flat before the corresponding rise commences, but the aneroid recorded almost exactly the same elevation for the top of the bank on that side, and we may therefore conclude that the lava once spread as a level sheet right across the present gorge, which has been since excavated to the depth mentioned.

The measurements just quoted show that the boulder bed is separated from the underlying eocene clays and limestones by not less than ninety-five feet of basalt, that is, from the outcrop of the latter at the base of the section to the first appearance of the conglomerate up the hill; moreover, from the fact that the quarry alluded to is situated at a lower level than the boulders, we may fairly infer the continuance of the igneous rock beneath them for their whole extent. If, in excavating the quarry, the fossiliferous boulders had been revealed, a different conclusion would be possible, as in that case they might simply represent a miocene inlier, surrounded and partially covered by a subsequent flow of lava. Such an explanation is, however, inadmissible, as they are not only absent there, but, as we have before said, do not show in any cutting or natural section along the river bank: and we are therefore driven to seek some other interpretation of the facts.

At Muddy Creek, as is well known, miocene strata are covered by a lava flow, usually regarded as of pliocene age, but that this was contemporaneous with the basalt overlying the eocene of the Leigh River, is, independently of the fossil evidence now presented, open to doubt. It is generally admitted that in the eocene, pliocene, and perhaps also the pleistocene periods, outpourings of lava took place over various portions of Southern Australia, but with one exception, the authors of recent memoirs on our tertiaries refrain from classing any of the basalts as miocene. If, however, the fossiliferous boulders of the Shelford section are miocene, the lava upon which they rest, may, provisionally at least, be referred to the same period—certainly it cannot be younger. Our theory, in fact, is that the Shelford basalt is a miocene flow covering the wide spread eocene strata of the region. Then, after the channel of the river had been partially excavated, the miocene conglomerate was deposited either in a slight depression hollowed out of the basalt, or upon its gently sloping surface. It is not unlikely that this portion of the Leigh River represents an old estuary connected with the former sea-channel, which, as pointed out by Mr. Murray, existed in tertiary times between the Cape Otway Ranges and the mainland to the north.* As the deposition of the boulders commences

* Geology and Physical Geography of Victoria, p. 122.

at about forty feet from the top of the bank, and continues for thirty-five feet lower down the hill, it follows that the estuary or inlet was invaded by the miocene sea until about one-third of the present depth of the gorge had been excavated. The conglomerate for the whole of the thirty-five feet of vertical extent in which it is traceable is intermingled with blocks of lava, and is therefore probably nothing more than a collection of scattered boulders resting on the basalt and not reaching far below the surface. The iron oxide in them is of course derived from the basalt, while the quartz pebbles plentifully intermixed with it were doubtless washed down from silurian country higher up the river.

The southern portion of the Leigh River has not been geologically surveyed, but in a report upon its upper course by Messrs. Etheridge and Murray, written in 1868, but not published till 1874,* it is incidentally remarked that the basalt around Shelford was derived from Mount Mercer, an extinct crater seventeen miles to the north. In describing the results of their detailed work, which was confined to the more northern area mentioned, the further statement is made that certain drifts and gravels, classed by them as pliocene underlie the same basalt. Such a position for pliocene strata is manifestly opposed to our theory that the igneous rock is not younger than miocene. It is possible that the basalt they refer to may belong to a different flow, more than one being mentioned in their report, but as we did not visit the sections in the surveyed area, we can offer no opinion upon the point. We may remark, however, that the geological ages of the various drifts and gravels of Victoria are not precisely known, the descriptive terms applied to them by the geological survey being admittedly, to some extent provisional. The best of all evidence is, of course, that afforded by marine fossils, but from the nature of the case, it is seldom available. Moreover, the revised nomenclature of the tertiaries adopted by the majority of recent writers has to be considered—if, as they contend, the former miocene of the survey has to be read as eocene, possibly also the term pliocene may, in some cases at least, need to be interpreted as miocene.

* Progress Report, No. II., p. 101, *et seq.*

The late Mr. Wilkinson, when a member of the Victorian Survey Staff, traced an old gravel from Steiglitz down the Moorabool, and in accordance with the classification of the tertiaries then current called it miocene, but which, as Mr. Pritchard has pointed out, should be altered to eocene or even pre-eocene.* In a similar manner, some of the so-called pliocene drifts and gravels may, when re-examined in the light of knowledge now possessed, prove to be of miocene age. In regard to those of the Leigh River Valley, reliable data for determining their geological horizon within narrow limits are, as we have seen, furnished by the marine beds with which they are associated. Further discussion of this subject would, however, be out of place in the present paper, and it is therefore postponed for some future occasion.

* Aust. Ass. Adv. Sci., Brisbane Meeting.